CLAIMS

1. A method of delivering liquid samples to a substrate, the method comprising:

dipping a slotted pin tool having an open tip into a sample reservoir containing a liquid sample to be delivered onto the substrate, thereby drawing a volume of liquid sample up into the pin tool;

moving the slotted pin tool from the sample reservoir to an elevated position above the substrate such that the pin tool is above a target location that is to receive the liquid sample; and

lowering the slotted pin tool toward the substrate at a predetermined speed and then halting the movement of the pin tool toward the substrate, thereby expelling the liquid sample from the slotted pin tool onto the target location of the substrate.

2. A method of claim 1, wherein halting the movement of the slotted pin tool toward the substrate occurs substantially when the open tip of the slotted pin tool contacts the substrate.

3. A method of claim 2, wherein the open tip of the slotted pin tool is adapted to fit around material deposited at the target location on the substrate without making contact with any portion of the material.

4. A method of claim 1, wherein the slotted pin tool has a substantially cylindrical tip having a lateral slot forming a cavity that fits around a material at the target location on the substrate.

5. A method of claim 1, wherein the slotted pin tool has a substantially cylindrical tip having a lateral slot forming a cavity with a width of greater than approximately 75 μm.

6. A method of claim 5, wherein the cavity of the cylindrical tip has a width between about 100 μm up to approximately 300 μm.

7. A method of claim 5, wherein the cavity of the cylindrical tip has a width between about 30 μm up to approximately 1000 μm.

8. A method of claim 5, wherein the cavity of the cylindrical tip has a height greater than approximately 100 μm

9. A method of claim 1, wherein dipping the pin tool comprises dipping the tip into the reservoir, whereby liquid is drawn into the slot.

10. A method of claim 1, wherein dipping the pin tool comprises dipping the tip into the reservoir such that the sample fluid level has a depth at least equal to the height of the slot in the tip, and the dipping halts when the pin tool has been dipped to a depth equal to the pin tool slot.

11. A method of claim 1, wherein positioning of the slotted pin tool is effected by pattern recognition to determine correct positioning above the substrate and, then moving the slotted pin tool to the determined position.

12. A method of claim 1, wherein moving the slotted pin tool comprises identifying an orientation mark on the substrate that indicates an appropriate location of the substrate.

13. A method of claim 1, wherein lowering the slotted pin tool comprises moving the slotted pin tool at a predetermined speed of lowing.

14. A method of claim 1, further comprising changing the volume of liquid sample delivered onto the substrate by changing the speed of lowering.

15. A method of claim 14, wherein the speed of lowering is changed in response to known composition of the liquid sample.

16. A method of claim 1, further comprising:

cleaning the slotted pin tool in a liquid bath after a first liquid sample has been delivered; and

drying slotted pin tool prior to dipping the pin tool in the liquid sample.

17. A method of claim 16, wherein cleaning and drying occur after the first liquid sample has been delivered and before a second liquid sample is delivered.

18. A method of claim 16, wherein drying comprises moving an air flow air over the slotted pin tool.

19. A method of claim 16, wherein the liquid bath comprises an ultrasonic bath.

20. The method of claim 1, wherein the sample comprises matrix material for mass spectrometric analyses.

21. A method of claim 5, wherein the cavity of the cylindrical tip has a width between about 100 μm up to approximately 500 μm.

22. The method of claim 12, wherein the orientation mark comprises a symbology, or an electronic tag or a physical deformation of the substrate for identification of orientation and/or identification of the substrate from among a plurality thereof.

23. A system for delivery of liquid samples from one or more pin tools to target locations on a substrate, the system comprising:

a plurality of processing stations, each of which performs a procedure on the pin tool, wherein the pin tool includes a lower tip having a slot into which a liquid sample may be drawn;

a transport system that transports the slotted pin tool from processing station to processing station; and

a control system that loads the slotted pin tool by moving it to a loading station at which the slotted pin tool is loaded with the liquid sample, then moves the slotted pin tool to an elevated position above the substrate such that the pin tool is above a target location that is to receive the liquid sample, and then dispenses the liquid sample by lowering the slotted

pin tool toward the substrate at a predetermined speed and then halts the movement of the pin tool toward the substrate, thereby expelling the liquid sample from the slotted pin tool onto the target location of the substrate.

24. A system of claim 23, wherein the control system halts the movement of the slotted pin tool toward the substrate substantially when the open tip of the slotted pin tool contacts the substrate.

25 A system of claim 24, wherein the open tip of the slotted pin tool is adapted to fit around a material at the target location on the substrate without making contact with any portion of the material.

26. A system of claim 23, wherein the slotted pin tool has a substantially cylindrical tip having a lateral slot forming a cavity that fits around a material at the target location on the substrate.

27. A system of claim 23, wherein the slotted pin tool has a substantially cylindrical tip having a lateral slot forming a cavity with a width of greater than approximately 100 μm.

28. A system of claim 27, wherein the cavity of the cylindrical tip has a width of approximately 300 μm.

29. A system of claim 27, wherein the cavity of the cylindrical tip has a height greater than approximately 100 μm.

30. A system of claim 23, wherein the control system loads the slotted pin tool by dipping the tip of the pin tool into a sample-containing reservoir at the loading station; and the control system halts the dipping substantially when the pin tool has been dipped to a depth equal to the pin tool slot.

31. A system of claim 23, wherein the control system moves the slotted pin tool to the elevated position using pattern recognition techniques to determine correct positioning above the substrate.

32. A system of claim 23, wherein the control system moves the slotted pin tool to the elevated position by identifying an orientation mark on the substrate that indicates an appropriate location of the substrate.

33. A system of claim 23, wherein the control system lowers the slotted pin tool by moving the slotted pin tool at a predetermined speed of lowering.

34. A system of claim 33, wherein the control system changes the volume of liquid sample delivered onto the substrate by changing the speed of lowering.

35. A system of claim 33, wherein the control system changes the speed of lowering in accordance with known composition of the liquid sample.

36. A system of claim 23, wherein the control system further moves the slotted pin tool by cleaning the slotted pin tool in a liquid bath after a first liquid sample has been delivered and drying the slotted pin tool prior to dipping the pin tool in the liquid sample.

37. A system of claim 36, wherein the control system performs cleaning and drying after the first liquid sample has been delivered and before it delivers a second liquid sample.

38. A system of claim 36, wherein drying comprises moving an air flow air over the slotted pin tool.

39. A system of claim 36, wherein the liquid bath comprises an ultrasonic bath.

40. A pin tool for use in a sample delivery system, the pin tool comprising one or more slotted pins each having an open tip adapted to fit around a material at a target location on a substrate without making contact with any portion of the material, wherein:

the slotted pin tool is adapted to be dipped into a sample reservoir containing a liquid sample to be delivered onto the substrate, thereby drawing a volume of liquid sample up into the slotted pins in the pin tool.

41. A pin tool of claim 40, wherein a pin in the pin tool has a substantially cylindrical tip having a lateral slot forming a cavity with a width of greater than approximately 75 μm.

42. A pin tool of claim 41, wherein the cavity of the cylindrical tip has a width up to approximately 500 μm.

43. A pin tool of any of claims 40, wherein the cavity of the cylindrical tip has a height greater than approximately 100 μm.

44. A combination of a pin tool of claim 41 and a substrate comprising target loci for deposition of sample material, wherein the array of pins in the pin tool is matched to the array of loci on the substrate.

45. A substrate for use in mass spectrometric analyses, comprising target locations defined by application of photoresist materials and photolithographic deposition; wherein the resulting array of target locations on the substrate are less hydrophobic than the surrounding areas.

46. A substrate of claim 45, wherein a substrate starting surface is comprised of a material that has an available -OH or primary amine.

47. The substrate of claim 45, wherein:

the substrate comprises two materials such that the one material has a contact angle that differs by at least about 20 degrees from the second material.

48. The substrate of claim 47, wherein the first material is poly-tetrafluoroethylene or a derivative thereof or is dimethyldichlorosilane (DMDCS); and the second material is silicon or silicon dioxide, which form the target loci.

49. A combination of a pin tool and the substrate of claim 48, wherein the pin tool comprises at least one pin that is slotted.

50. A combination comprising:

a substrate, comprising an array of target locations on a surfaces, wherein the target locations less hydrophobic than the surrounding areas; and

a pin tool comprising at least one pin having a substantially cylindrical tip with a lateral slot forming a cavity that fits around a material deposited at a target location on the substrate.

51. A combination of claim 50, wherein the pin has a substantially cylindrical tip having a lateral slot forming a cavity with a width of greater than approximately 75 μm, preferably greater than 100 μm.

52. A combination of claim 50, wherein the cavity of the cylindrical tip has a width between about 100 μm up to approximately 300 μm.

53. A combination of claim 50, wherein the cavity of the cylindrical tip in a pin has a height greater than approximately 100 μm.

54. A combination of claim 50, wherein:

the slotted pin tool is adapted to be dipped into a sample reservoir containing a liquid sample to be delivered onto the substrate, thereby drawing a volume of liquid sample up into the slotted pins in the pin tool, and then is moved to an elevated position above the substrate such that the pin tool is above the target location(s), and then is lowered toward the substrate such that upon halting the movement thereof the liquid sample is expelled from the slotted pin tool onto the target location of the substrate.

55. A method of mass spectrometric analysis, comprising:

depositing matrix material and sample on the target loci of a substrate of claim 45;

introducing the substrate into a mass spectrometer for analysis of the samples; and

analyzing the samples by mass spectrometry.

56. The method of claim 55, wherein the sample comprises nucleic acids or proteins.

57. A method of preparing a substrate, comprising:

coating a surface of a substrate with a photoresist material and solidifying it on the surface;

exposing the surface through a mask to light of a wavelength that permits removal of the photoresist from exposed surface;

washing the photoresist off with a developer leaving an array of photoresist pads having on the surface;

baking the resulting substrate.

58. The method of claim 57, wherein the substrate is baked at between about 190-200° C for a period of about 50-70 minutes.

59. The method of claim 57, wherein the photoresist contains a diazonaphthoquinone sensitizer and a phenolic resin.

60. The pin tool of claim 40, wherein a pin in the tool is tapered.